

CLAIMS

1. A process for manufacturing a water-resistant telecommunication cable comprising a solid and compact element housing at least one transmitting element, wherein
5 the solid and compact element comprises a water-soluble polymer material comprising:

-a vinyl alcohol/vinyl acetate copolymer having a hydrolysis degree of 60-95% and a polymerisation degree higher than 1,800;

10 -at least a first solid plasticizer, having a melting point of 50-110°C, and a second solid plasticizer, having a melting point equal or higher than 140°C, in an amount of 10-30 and 1-10 parts by weight per hundred parts by weight of the copolymer, respectively;

15 the water-soluble polymer material showing:

-a complex modulus (G^*) equal or higher than 2.5×10^6 MPa;

-a ratio of the viscous modulus to the elastic modulus ($\tan \delta$) equal or lower than 2.30;

-a glass transition temperature (T_g) of 20-35°C;

20 the process comprising producing in continuous the water-soluble polymer material by separately feeding in sequence a multi-screw extruder, in the flow direction, with:

25 -the copolymer and the second solid plasticizer, melting and mixing them at 170-220°C;

-the first solid plasticizer, melting and mixing it with the second solid plasticizer and the copolymer at 140-180°C; subsequently homogenizing the copolymer and the plasticizers at 100-150°C and finally discharging the melt, at a
30 temperature lower or equal to 205°C.

2. Process according to claim 1, wherein the solid and compact element comprises 30% by weight or more of the water-soluble polymer material.

3. Process according to claim 1 or 2, wherein the solid
35 and compact element comprises 50% by weight or more of the

water-soluble polymer material.

4. Process according to any of the previous claims, wherein the solid and compact element comprises 75% by weight or more of the water-soluble polymer material.

5 5. Process according to any of the previous claims, wherein the solid and compact element is a structural element of the cable. .

6. Process according to any of the previous claims, wherein the solid and compact element is a tubular element
10 comprising at least one sheath comprising the water-soluble polymer material.

7. Process according to claim 6, wherein the tubular element is a single sheath substantially made of the water-soluble polymer material.

15 8. Process according to claim 6, wherein the tubular element is a double layer sheath, the inner layer being made of the water-soluble polymer material and the outer layer being made of a water-insoluble polymer material.

9. Process according to claim 6, wherein the tubular
20 element is a three-layer sheath, the inner and the outer layers being made of the water-soluble polymer material and the intermediate layer being made of a water-insoluble polymer material.

10. Process according to any of the previous claims,
25 wherein the solid and compact element is a buffer tube and the transmitting element is an optical fibre.

11. Process according to any of the previous claims, wherein the copolymer is in an amount of 50-95% of the total weight of the water-soluble polymer material.

30 12. Process according to any of the previous claims, wherein the copolymer is in an amount of 60-85% of the total weight of the water-soluble polymer material.

13. Process according to any of the previous claims, wherein the copolymer has a hydrolysis degree of 70-92% and
35 a polymerisation degree of 2,500-3,700.

14. Process according to claim 13, wherein the copolymer has a polymerisation degree of 3,000-3,500.

15. Process according to any of the previous claims, wherein the first and the second plasticizers are in an amount of 12-25 and 3-7 parts by weight per hundred parts by weight of the copolymer, respectively.

16. Process according to any of the previous claims, wherein the first and second plasticizers are polyhydric alcohols.

17. Process according to any of the previous claims, wherein the first plasticizer is selected from sorbitol, trimethylolpropane, di-trimethylolpropane, methylpropyl propanediol, and mixtures thereof, and the second plasticizer is selected from mannitol, pentaerythritol, dipentaerythritol, trimethylolethane, and mixtures thereof.

18. Process according to any of the previous claims, wherein the first plasticizer is trimethylolpropane or di-trimethylolpropane and the second is pentaerythritol or dipentaerythritol.

19. Process according to any of the previous claims, wherein the first and the second plasticizer are in an amount of 20 and 5 parts by weight per hundred parts by weight of said copolymer, respectively.

20. Process according to any of the previous claims, wherein the water-soluble polymer material comprises a third plasticizer, liquid at room temperature, in an amount of 0.5-10 parts by weight per hundred parts by weight of the copolymer, the third plasticizer being fed, after the copolymer and the second plasticizer, at 170-220°C.

21. Process according to claim 20, wherein the third plasticizer is a polyhydric alcohol.

22. Process according to claim 20 or 21, wherein the third plasticizer is selected from glycerol, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol,

trimethylolpropane ethoxylates, pentaerythritol ethoxylates, and mixtures thereof.

23. Process according to any of claims 20 to 22, wherein the third plasticizer is in an amount of 2-7 parts by weight per hundred parts by weight of said copolymer.

24. Process according to any of claims 20 to 23, wherein the third plasticizer is in amount of 5 parts by weight per hundred parts by weight of said copolymer.

25. Process according to any of claims 20 to 24, wherein the third plasticizer is diethylene glycol or triethylene glycol.

26. Process according to any of claims 20 to 25, wherein the third plasticizer is fed before the first solid plasticizer.

27. Process according to any of the previous claims, wherein the complex modulus (G^*) is between 3.0×10^6 and 4.0×10^6 MPa.

28. Process according to any of the previous claims, wherein the ratio of the viscous modulus to the elastic modulus ($\tan \delta$) is between 0.5 and 2.0.

29. Process according to any of the previous claims, wherein the glass transition temperature (T_g) is between 25° and 30°C.

30. Process according to any of the previous claims, wherein the the melting and mixing of the copolymer and the second solid plasticizer are carried out at 180-210°C.

31. Process according to any of the previous claims, wherein the the melting and mixing of the first plasticizer with the copolymer and the second solid plasticizer are carried out at 150-170°C.

32. Process according to any of the previous claims, wherein the homogenization of the copolymer with the plasticizers is carried out at 110-140°C.

33. Process according to any of the previous claims, wherein the discharging of the melt is carried out at a

temperature lower or equal to 195°C.

34. Process according to any of the previous claims, wherein the water-soluble polymer material comprises a hydrolysis stabilizer compound comprising a chelant group
5 comprising two hydrogen atoms bonded to two respective heteroatoms selected from nitrogen, oxygen and sulphur, said two hydrogen atoms having a distance between each other of from 4.2×10^{-10} m to 5.8×10^{-10} m, said stabilizer compound being present in an amount of at least 0.75 mmols per 100 g
10 of the copolymer.

35. Process according to claim 34, wherein the stabilizer is fed together with the copolymer and the second solid plasticizer.

36. Process according to claim 34 or 35, wherein the
15 stabilizer is N,N'-hexane-1,6-diylbis(3-(3,5-di-ter-butyl-4-hydroxyphenylpropionamide)).

37. Process according to any of the previous claims, wherein the multi-screw extruder is a self-cleaning co-rotating fully intermeshing twin screw extruder, a Buss
20 kneader, a Ring extruder RE[®] or a Farrell FCM[®] extruder.

38. Process according to any of the previous claims, wherein the multi-screw extruder provides an energy input of 0.15-0.50 kWh/kg to the water-soluble polymer material.

39. Process according to any of the previous claims,
25 wherein the multi-screw extruder provides an energy input of 0.30-0.40 kWh/kg to the water-soluble polymer material.

40. Process according to any of the previous claims, wherein the multi-screw extruder has a multi-zone thermally controlled barrel.

30 41. Process according to any of the previous claims, wherein the multi-screw extruder comprises a thermal control apparatus.

42. Process according to claim 41, wherein the thermal control apparatus comprises an electrical system for heating
35 and a water system for cooling.

43. Process according to any of the previous claims, wherein a pressure build-up system followed by a die head are provided at the end of the multi-screw extruder.

44. Process according to claim 43, wherein the pressure
5 build-up system is a tight pitch conveying section in the multi-screw extruder, a gear pump or a single screw extruder flanged or in cascade to the multi-screw extruder.

45. Process according to claim 43 or 44, wherein a cutting device is provided after the die head.

10 46. Process according to claim 45, wherein the cutting device is a dry air cutting system or a strand pelletizing system with fast centrifuge water separation.

47. A process for extruding a water-soluble polymer material comprising:

15 -a vinyl alcohol/vinyl acetate copolymer having a hydrolysis degree of 60-95% and a polymerisation degree higher than 1,800;

-at least a first solid plasticizer, having a melting point of 50-110°C, and a second solid plasticizer, having a
20 melting point equal or higher than 140°C, in an amount of 10-30 and 1-10 parts by weight per hundred parts by weight of the copolymer, respectively;

the water-soluble polymer material showing:

-a complex modulus (G^*) equal or higher than 2.5×10^6 MPa;

25 -a ratio of the viscous modulus to the elastic modulus ($\tan \delta$) equal or lower than 2.30;

-a glass transition temperature (T_g) of 20-35°C;

the process comprising producing in continuous the water-soluble polymer material by separately feeding in
30 sequence a multi-screw extruder, in the flow direction, with:

-the copolymer and the second solid plasticizer, melting and mixing them at 170-220°C;

35 -the first solid plasticizer, melting and mixing it with the second solid plasticizer and the copolymer at 140-180°C;

subsequently homogenizing the copolymer and the plasticizers at 100-150°C and finally discharging the melt, at a temperature lower or equal to 205°C.

48. Process according to the previous claim, wherein the
5 process is according to any of claims 11 to 46.